ANNUAL PROGRESS REPORT

Prepared for

Los Angeles County Flood Control District

on

SEDIMENT MANAGEMENT FOR SOUTHERN CALIFORNIA MOUNTAINS, COASTAL PLAINS, AND SHORELINE

A Joint Project of the

Environmental Quality Laboratory
California Institute of Technology

and

Shore Processes Laboratory
Scripps Institution of Oceanography

January 1977

INTRODUCTION

During 1976, with financial support from Los Angeles County, U. S. Geological Survey, and discretionary funding provided by a grant from the Ford Foundation, substantial progress was made at EQL and SPL in achieving the objectives in the initial Planning and Assessment Phase of the CIT/SIO Sediment Management Project. The current timetable for completion of this phase is June 1978.

This report briefly describes the project activities during the year including general administration, special activities, and technical work; and is submitted in accordance with the letter of agreement between Los Angeles County and Caltech dated 1 April 1976.

ADMINISTRATION

In March of 1976 Los Angeles County awarded 30^k to the California Institute of Technology to be used for general project support. 10^k or one-third (1/3) of this award was forwarded to Scripps Institution of Oceanography for project support at the Shore Processes Laboratory under Dr. Douglas L. Inman.

During the year a major effort was put forth to establish and maintain close liaison with county flood control districts in the study area, and with appropriate state and federal agencies in an attempt to increase the technical involvement of these agencies, and to obtain financial support from all agencies that will derive substantial benefits from the CIT/SIO study.

In November 1976 the Corps of Engineers approved funding for the CIT/SIO project (50^k for two years). It is anticipated that first-year funding from COE will be forwarded to Caltech in February, 1977.

Also on November 30th, the Orange County Board of Supervisors allocated 30^k for direct project support during the current fiscal year, and in January 1977 a formal letter of agreement was signed.

A third new commitment of financial project support has been indicated by the Department of Navigation & Ocean Development in the State Resources Agency. This support is scheduled to start at the beginning of fiscal year FY 78.

With this growing financial resource the scale of the project effort will increase markedly during the coming year. However, additional commitments by other agencies will be necessary to enable the full-scale effort (see Appendix A for proposed FY 77 Project Budget) planned.

We are currently conducting negotiations for additional financial support with Sea Grant, U. S. Forest Service and the County of San Diego.

SPECIAL ACTIVITIES

During 1976 two special project activities were undertaken--a two-day workshop, and the introduction of a newsletter to report on the CIT/SIO study and other issues pertaining to regional sediment management.

The workshop was held at Caltech on March 15 and 16. Approximately 200 people attended, including representatives from 25 federal, state and local government agencies, 11 universities, public utilities, engineering and consulting firms, and the general public. (For list of attendees see Appendix B). Twenty-five technical papers were presented, 12 by representatives from federal, state and local government agencies, 11 by university associates, and two by representatives from private industry. This workshop helped to clarify important research questions pertaining to regional sediment management and to promote a cooperative research effort among institutions and agencies. The general conclusion of the workshop might be stated as follows: the large population, high level of development throughout the coastal region of southern California, and diverse and intense use of local resources for industry and recreation (some 50 million user-days of shoreline recreation and 10-14 million user-days of mountain and national forest recreation per year) underline the importance of understanding the natural sediment balance and the effects man has imposed on it. More thorough analyses of inter-regional

management strategies are needed to help ensure that we do not contradict our own efforts in attempting to solve existing sedimentation problems, and that our actions do not produce undesirable results that may be very costly or impossible to correct in the future.

The newsletter has been initiated to build upon and continue workshop objectives, i.e. provide a vehicle for a continuing informal exchange of ideas and information among managers, engineers, and scientists involved in sedimentation problems in southern California, and to disseminate information on the CIT/SIO project. This newsletter will be published periodically as necessary to meet these objectives. More than 1000 copies of the first newsletter, printed in November, were distributed to managers, engineers, academic people, county, state and federal political representatives, and other interested parties.

TECHNICAL WORK

Technical work at Caltech during the year has included data compilation: tabular, computerized data files, and mapping; and preliminary data analysis directed toward obtaining first-order estimates of the mean annual values of sediment movements from upland areas, and shoreline sediment deliveries under present and recent past conditions.

During 1976 the following data were compiled:

1. Streamflow data: daily mean and annual peak flows for several hundred large and small streams throughout the study area. A master list of all available streamflow records has been obtained from the California Department of Water Resources and has been entered onto magnetic tape for ready computer access. The list encompasses 852 stations in the study area at which streamflow data have collected. Some 450 of these stations have been operated by the U. S. Geological Survey, and the master computer files of the USGS have been accessed to transfer useful data to the Caltech files.

2. Sediment-transport data: daily mean discharges and individual sample data for both suspended-sediment and bedload transport. These USGS data

are derived from 32 stations in the study area, of which

a) 20 stations have from 1 to 9 years of continuous records;

b) 19 stations, primarily on upland drainages in the Santa Clara River basin, have partial records;

c) 2 stations (the Los Angeles and San Gabriel Rivers near their mouths) were established in late 1975 specifically for the CIT/SIO project;

d) 10 stations have 1 to 2 years of bedload data;

e) 11 of the 20 stations above are on the main stems of rivers near their points of discharge to the ocean.

One hundred and ten station-years of daily suspended-sediment discharge data are available from the USGS. These data have been obtained in punched-card format and have been entered onto magnetic tape and disk. Data on the particle-size distribution of suspended sediment and bedload are being entered onto computer cards for immediate analysis and subsequent entry onto tape or disk.

3. Geologic data: regional and subregional geologic maps from which initial estimates of erodibility of surficial materials may be made. Surficial geology for the study area is being compiled on a single 1:250,000 base map from six 1:250,000 maps of the Geologic Atlas of California. Geology for selected parts of the study area will be compiled at a scale of 1:24,000.

4. Aerial imagery: an inventory of existing imagery shows that more than 100,000 images are available for the study area from the USGS, National Aeronautics and Space Administration, U. S. Forest Service, and other public and private sources. A compilation of flight lines, image centers, and image scales for USGS, NASA, NOAA, and USFS data is now on file at Caltech. Additional aerial photography is available at Scripps. A precision scanning stereoscope has been loaned to the project by the USGS for inspection and analysis of stereoimagery. EQL is currently selecting from this data set a reasonable, useful amount of aerial imagery on which we can build as the project progresses.

5. Beach and offshore sediment-size data: size-distribution data for 95 samples in Ventura, Los Angeles, Orange, Santa Barbara, and San Diego

Counties by the Los Angeles District, Corps of Engineers, for the period 1967-69. More than 350 additional sand samples at various locations along the coast of the study area were obtained and analyzed by the Corps from 1963 to 1966. These data will be used initially to identify areas that lack a suitable data base so that an appropriate sampling program may be instituted.

6. Fire history data: the acreage burned, locations and dates of forest and brush fires that have occurred in the study area during the past 75+ years. These data have been collected from county agencies and the U. S. Forest Service.

7. Sand and gravel mining data: location, quantity, and size distribution of sand and gravel mined in the study area. These data will be used to help assess the magnitude of usage and movement of sediment by human activity. A detailed knowledge of the demand for sand and gravel will aid in weighing alternatives for disposal of material that must be excavated from flood-control and debris basins.

Work has also been done on preparing four different map types:

1. fire history
2. annual surface runoff
3. geomorphic land types in terms of sediment erosion potentials
4. drainage basin controls

(See Appendix C for a more detailed description of maps).

Using the data compiled thus far, some preliminary estimates have been obtained for regional sediment budget factors characterized schematically in Figure 1.

The debris accumulation and sediment discharge data from Ventura, Los Angeles, Riverside, Orange, and San Diego Counties were used to obtain estimates of the mean annual denudation (surface erosion) rates. The results indicate that to a first approximation, there are three characteristically different types of 'erosional' land forms in the study area. The first is mountainous areas, characterized by steep slopes, well-defined features and abrupt vertical reliefs of thousands of meters. This land form is primarily the result of two extremely active morphologic

processes: tectonic faulting, and hydraulic erosion. For this land type longer-term mean annual erosion rates of from approximately .7 - 2. mm/yr have been measured.

The second land type is hill areas. These areas are geologically mature and have well-rounded features with moderate vertical reliefs of several hundred meters. Limited available data suggest denudation rates in hill areas of approximately .2 - .4 mm/yr.

The third type - flatter coastal and upland plain areas, is noted for its smooth features, very gradual slopes, and low relief (tens of meters). Although this land type does yield sediment, the amount is small ($\sim$.01 mm/yr). Plain areas serve primarily as intermediate depositional zones between mountain and hill areas and the shoreline. (In some areas, however, the mountain and hill areas drain directly to the shoreline.) Hence, there is generally a net long-term aggradation on plain areas.

Based on these values of mean annual denudation rates, in conjunction with a generalized land form classification of the study area, preliminary estimates can be made of mean annual sediment erosion from mountain, hill and plain areas, as follows:

Land Form Areas

Mountains	8,800	Km^2
Hills	8,600	
Plains	12,600	
	30,000	Km^2

Land Form Erosion (Mean Annual)

	Unit Rate	Aggregate (all sizes)
Mountains	1. mm/yr	8.8 Million M^3/yr
Hills	0.3	2.6
Plains	0.01	0.1
		11.5 Million M^3/yr

Using the sediment size classification and estimates of particle size distribution shown in Figure 2, the following estimates have been computed for sand (0.064 - 2. mm) production.

Sand Production (Mean Annual)

Mountains	3.1 Million M^3/yr
Hills	1.0
Plains	0.02
	4.1 Million M^3/yr

In the study area, sediment deliveries to the shoreline originate from nine major rivers, and more than 80 smaller streams that drain from coastal plains and directly from mountain and hill areas to the shoreline. Based on sediment discharge accumulation, and streamflow data already compiled at Caltech, estimates have been made of annual sand deliveries to the shoreline, as follows:

Sand Discharge to Shoreline Areas

	Estimated Annual Average*	% of Total	1969 Flood
Major Rivers	M^3		
Ventura	115,000	12 %	
Santa Clara	460,000	47	10,100,000
Los Angeles	(small)**	--	
San Gabriel	(small)**	--	
Santa Ana	40,000	4	2,200,000
San Luis Rey	20,000	2	
Santa Margarita	40,000	4	
San Diego	60,000	6	
Tiajuana	10,000	1	
Smaller Streams			
San Juan Creek	40,000	4	1,150,000
Other Streams	200,000	20	
Total	985,000	100 %	

*Based on 1951-74 period of record. For these estimates it was assumed that sand transport is equal to 30% of total sediment transport.

**(Sediment discharge data collected by USGS for the 1976 water year has not yet been reduced. The indicated estimate is based on the probable effects of upstream controls).

These estimates suggest that at present approximately 1/4 of the sand produced by land surface erosion is eventually delivered to the shoreline area.

The above table also gives single-year (1969) estimates on three streams. These data suggest that there can be a large variation in annual values of shoreline sand delivery. Data in the following table, collected by the USGS on the Santa Clara River which is relatively uncontrolled further illustrates this annual variation.

Variation in Suspended Sediment Transport (all sizes) by Santa Clara River Near Mouth

Water Year	Annual Transport	Equivalent Erosion Rate
	Millions M^3	MM/yr
1968	0.043	0.01
1969	29.	6.9
1970	0.38	0.090
1971	1.4	0.33
1972	0.27	0.064
1973	2.4	0.59

The significant fluctuations in annual sand supply to the shoreline indicated by these data suggest that under natural conditions there can be significant multiple-year fluctuations in shoreline configuration and beaches near major river mouths. The amplitude and down-shore extent of these natural fluctuations has not yet been determined.

Preliminary data indicate that during the past 30 years, several hundred million M^3 of sedimentary material have been mined by sand and gravel producers, some 40 M^3 of sediment has been removed and relocated from reservoirs and debris basins, and more than 80 million M^3 of sand-sized sediment has been artificially placed on beaches in southern California for widening and nourishment through coastal dredging operations. Additional dredged sediment has been used for land fill and disposed of in offshore areas.

These data suggest that the scale of man-induced sediment movements is of the same order of magnitude (1-10 million M^3/year) as natural sediment movements, and more importantly, that in the case of beach changes and nourishment the effects of man's activities on the natural sediment balance have been of first-order.

At present, in addition to ongoing data compilation and the mapping tasks described previously, work is under way to improve the above estimates of erosion from mountain and hill areas by identifying improved causal parameters and developing a more accurate model which may be used to estimate time series of annual sediment yields from unmeasured watersheds. This will enable a more specific and geographically detailed definition of sediment production from upland areas.

In conjunction with this work, efforts are under way to obtain accurate estimates of yearly sediment deliveries (by general size fraction) to the shoreline based on (a) actual conditions that existed, and (b) natural streamflows that would have obtained without artificial controls. This analysis will enable reasonable estimates of the effects upstream control structures have had on sediment deliveries to the shoreline area during the past 50 years (1925-75).

There is also an ongoing effort to compile additional, more precise data on man-induced sediment movements and their geographical distribution during the past 75+ years.

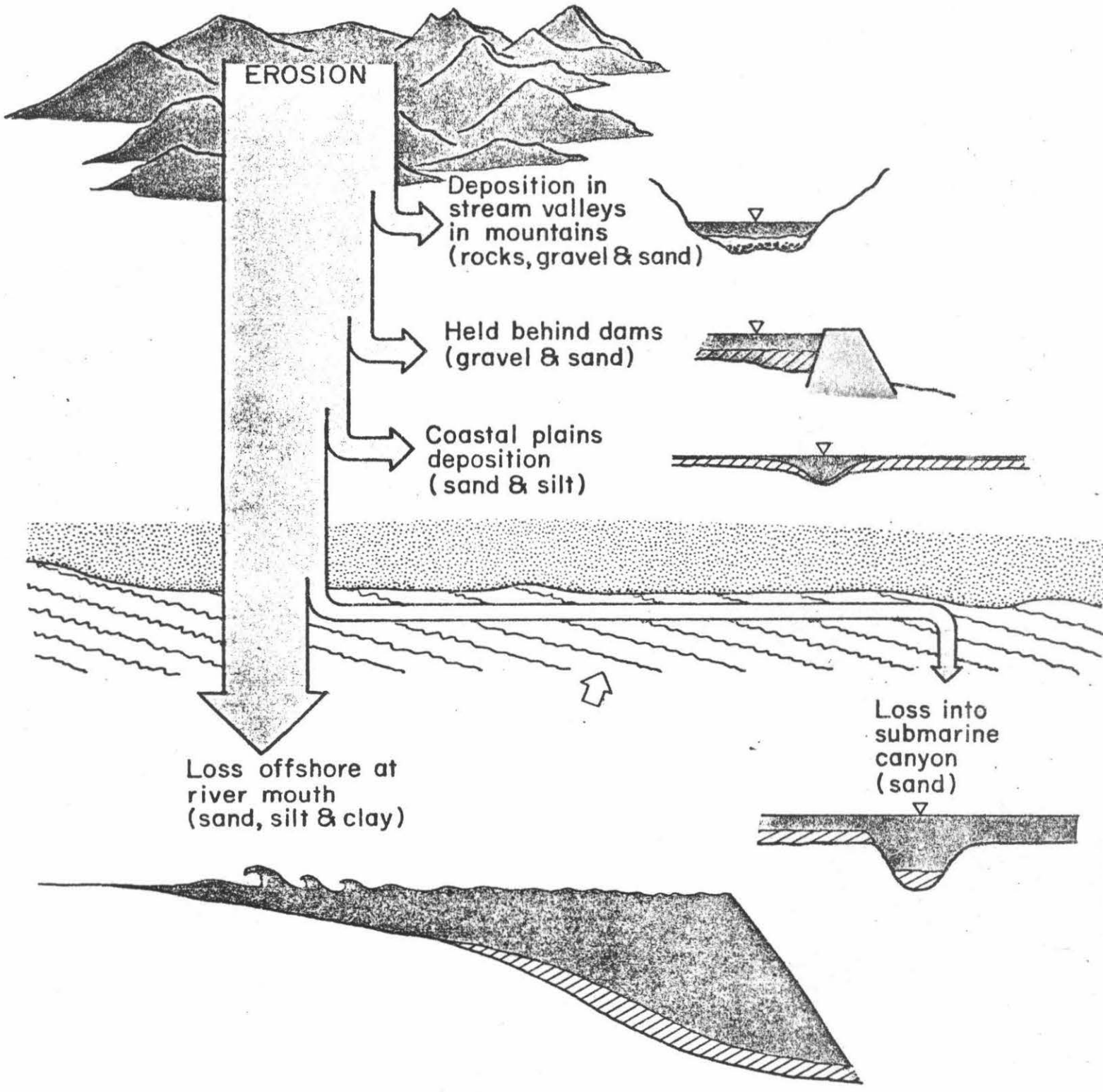
At Scripps during the past few months, efforts have been under way to inventory and compile the large body of beach profile data collected by the Corps of Engineers, and State and County agencies over the past 30 - 50 years. This data will be used to define seasonal fluctuations and long-term changes in sand level on the beaches in the study area. The results of this effort should define the range of seasonal changes in beach configuration throughout the study area and indicate those areas that are undergoing a general depletion of beach sand.

A second study at Scripps is the compilation of longshore transport data for the study area in terms of the littoral cell concept. This effort involves the evaluation of all available longshore transport data for each of the five major littoral cells defined in the southern California region (Figure 3). Each littoral cell will then be examined in terms of its sediment budget: the input from land versus the losses to offshore basins and downcoast cells. This type of analysis will show which cells have insufficient sediment input to balance their apparent longshore transport potential.

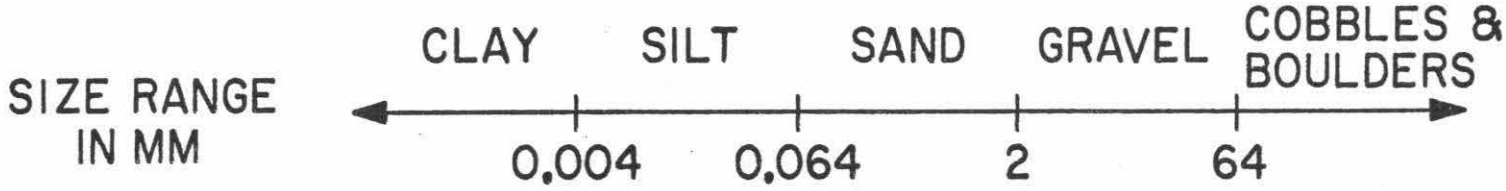
Appendix B contains tentative outlines of all sub-tasks that are intended for the Caltech and Scripps efforts, respectively, during the Planning and Assessment Phase of the Sediment Project. Also included with this outline is a tentative work schedule chart, and a list of specific project output intended during the initial project phase.

FIGURES

Figure 1


EROSION
Deposition in stream valleys in mountains (rocks, gravel & sand)
Held behind dams (gravel & sand)
Coastal plains deposition (sand & silt)
Loss into submarine canyon (sand)
Loss offshore at river mouth (sand, silt & clay)

GENERAL SEDIMENT SIZE CLASSIFICATION



PERCENTAGES FOR:	CLAY + SILT	SAND	GRAVEL + COBBLES & BOULDERS
MOUNTAIN EROSION	50%	35%	15%
HILL EROSION	60%	40%	—
PLAINS EROSION	80%	20%	—

Figure 2

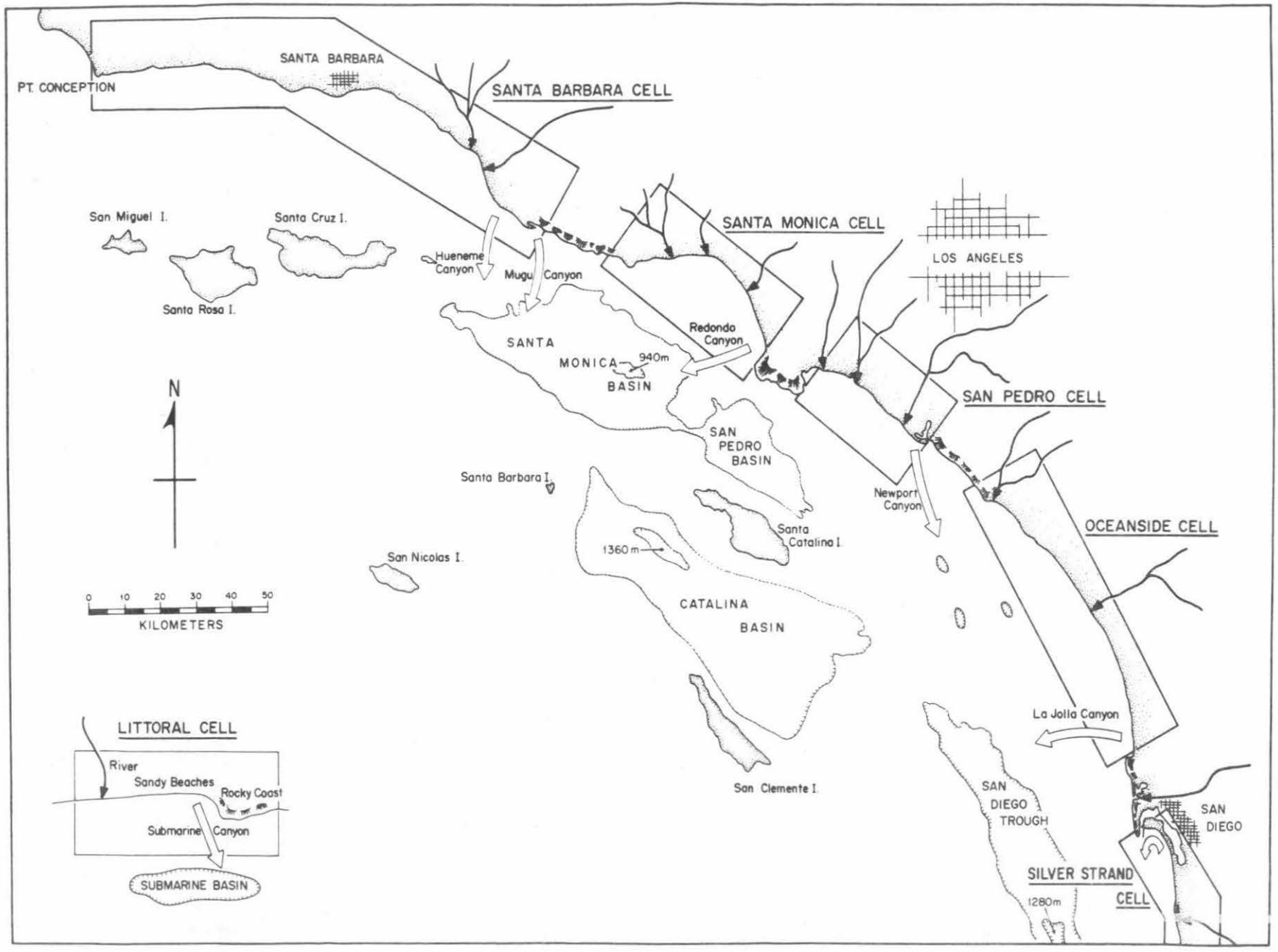


FIGURE 3. Littoral Cells in Southern California

APPENDICES

APPENDIX A

PROPOSED

CIT/SIO SEDIMENT MANAGEMENT PROJECT BUDGET*
Oct. 1, 1976 - Sept. 30, 1977

Budget for Expenditures

A. SCRIPPS INSTITUTION OF OCEANOGRAPHY		Total Budget $ Thousands
Staff		
C. E. Nordstrom (50%)		9.9
Staff Research Associate (100%)		18.3
Secretary		6.3
Scientific Illustrator (75%)		9.3
Graduate Research Assistants (2) (50% for 9 mos., 100% for 3 mos.)		13.1
Total salaries		56.9
Benefits @ 11.8%		6.7
		63.6
Supplies and expense		5.4
Travel		4.9
Equipment		1.8
Misc.		3.0
		15.1
Total Direct Costs		78.7
Overhead @ 34.2% excl. equipment		26.3
	TOTAL	$105.0

*Target budget initially proposed in August 1976; actual expenditures will be somewhat less and limited to availability of supporting funds.

Budget for Expenditures

B. CALTECH	Total Budget $ Thousands
Professional Staff	
Norman H. Brooks, Director of Environmental Quality Laboratory, Prof. of Environmental Engineering Science and Civil Engineering (Principal Investigator)(sedimentation engineering, hydrology, hydraulics)	4.0**
R. C. Y. Koh, Research Associate in Environmental Engineering Science (hydraulics, computers, data systems, analysis)	8.0
E. John List, Associate Professor of Environmental Engineering Science (hydrologic systems, fluid mechanics)	2.0
Fredric Raichlen, Professor of Civil Engineering (coastal engineering)	2.0
Brent D. Taylor, Senior Research Engineer; Project Manager (sedimentation engineering, hydraulics)	19.0
Economist (to be identified)	3.0
William M. Brown III	***
	38.0
Graduate Students	
William R. Brownlie, Graduate Res. Asst., Ph.D. Candidate in hydraulics	3.0
Other	3.0
	6.0
Undergraduates	4.0
Supporting Staff	
Secretary (75%)	7.2
Research Assistants (2)	21.6
	28.8
Reserve for Salary increases	3.0
Total Salaries	79.8

** Allocations based on individual annual salaries (11 month) and percent of time to be spent in project activities.

*** No project cost, value approximately 30^{k}/yr.

Budget for expenditures
Caltech (continued)

		$ Thousands
		79.8
Benefits @ 20.6% excl. undergraduates		15.6
		95.4
Supplies and expense		8.0
Travel		2.5
Equipment		9.0
Computing Charges		5.5
Consultants		1.5
		26.5
		121.9
Overhead @ 45% (total excluding equipment)		50.8
	TOTAL	$172.7

BUDGET SUMMARY

Scripps Institution of Oceanography	$105.0
California Institute of Technology	172.7
CIT Management Fee (Subcontract to SIO)	7.2
	$284.9
ROUNDED	$285.0[k]

APPENDIX B

SEDIMENT MANAGEMENT CONFERENCE, 15-16 MARCH 1976

List of Attendees *

Allen, Gerald - Fugro, Inc., Long Beach
Anderson, Henry W. - U.S. Forest Service, Berkeley
Andrews, Ned - Dept. of Geology, UC Berkeley
Angelos, Richard E. - Calif. Dept. of Water Resources, L.A.
Appel, David H. - USGS, Laguna Niguel
Armstrong, George A. - State of California, Dept. of NOD, Sacramento
Aubrey, David - Scripps Institution of Oceanography, La Jolla
Aulick, Mike - Comprehensive Planning Organization, San Diego
Aygarn, Ron - Angeles National Forest, Pasadena

Baumli, George R. - Dept. of Water Resources, L.A.
Bellmer, Russ - Corps of Engineers, L.A.
Berry, Joe - San Diego Flood Control Dist.
Bertucci, William F. - Marine Bio. Cons., 947 Newhall, Costa Mesa
Bickel, Gerald - Ventura County Public Works
Boehm, John C. - Reg. Water Quality Cont. Bd., L.A.
Brady, Matthew - Calif. State Lands Comm., Sacramento
Brancheau, Ed - San Diego Gas & Elec.
Brisco, John - Office of Attorney General, San Francisco
Brooks, Norman - EQL, Caltech
Browand, F. K. - USC
Browerman, Frank - CDM, Inc. Environmental Engineers, Pasadena
Brown, William - EQL, Caltech
Bruington, Arthur - L.A. County Flood Control Dist.
Bruno, Richard O. - Army CERC, Pt. Mugu
Bugescu, Ibolya - Cal State Long Beach
Bulot, Mark - Fourth Street Rock Crusher, San Bernardion
Burtman, L. - San Diego Water Quality Cont. Bd.

Cain, Robert E. - City of San Diego
Caldwell, Joe - consulting engineer, Arlington, Virginia
Campo, Paul - Nat. Res. Off., Marine Corps Base, Camp Pendleton
Cass, Glen - Caltech
Chang, Howard H. - San Diego State U
Chen, Kenneth - Env. Eng. Prog., USC
Chu, H. L. - Cal State Long Beach
Cleveland, George - State Div. Mines & Geol., Cal Poly, San Luis Obispo
Clifton, H. Edward - USGS, Menlo Park
Collins, Win S. - Corps of Engineers, L.A.
Conrad, C. Eugene - San Dimas Experimental Forest, Glendora
Copeland, Ronald - Corps of Engineers, L.A.
Costa, Steve - Foundation of Ocean Research, San Diego
Couchman, Walter - City Engineers Office, L.A.
Crandall, Thomas A. - State of Calif., San Diego Coast Reg. Comm.
Culbertson, Don - USGS, Menlo Park
Cushman, Marjorie - Corps of Engineers, L.A.

* Incomplete

Davis, J. Dan - L.A. County Flood Control Dist.
Dean, E. Nelson - San Bernardino National Forest
Delaney, Ladin H. - Calif. Reg. Wtr. Qual. Cont. Bd., San Diego Region
De La Parra, Ralph - Southern Calif. Edison, Rosemead
Dingler, John R. - USGS, Menlo Park
Dudley, George A. - Calif. Div. of Forestry, Riverside
Durkan, Ray - Caltech

Eagleson, Peter - Caltech
Eilers, Peter H. - Dept. of Geog., Cal State Fullerton
El-Fadly, Abdel Hamid - Cal State Long Beach
Emigh, Glenn - Corps of Engineers, L.A.
Engstrom, Wayne N. - Dept. of Geog., Cal State Fullerton
Eshelby, Courtice F. - L.A. County Flood Control Dist.
Eshett, Ali - Cal State Long Beach

Fisher, Charles N. - Corps of Engineers, L.A.
Frank, Franklin - Calif. Div. of Forestry, Sacramento
Frank, William - Ventura County Public Works Agency
Frautschy, J. D. - Scripps Institution of Oceanography, La Jolla

Garrett, Allen W. - Corps of Engineers, L.A.
Ginn, George W. - Calif. State Lands Div., Long Beach
Gonzales, Dionicio - Corps of Engineers, L.A.
Goring, Derek - Caltech
Gorsline, D. S. - Dept. of Geol. Sci., USC
Gray, Donald - Oak Ridge Nat. Lab., Oak Ridge, Tennessee
Greenhood, Joan - San Diego Flood Control Dist.
Grove, Robert - Southern Calif. Edison, Rosemead

Habel, John - Dept. of NOD, Sacramento
Hale, John S. - Dept. of County Eng., L.A.
Hall, Omeir D. - L.A. County Flood Control Dist.
Hashimoto, Lewis - Caltech
Hatfield, Don - S&F/C County of San Diego
Hayter, William - State Lands Comm., Sacramento
Heacox, Lynn J. - Coastal Zone Comm., Long Beach
Helm, Haden - Corps of Engineers, L.A.
Herrera, Stephen - Calif. Reg. Wtr. Qual. Cont. Bd., Santa Ana Region
Herron, William J. - Moffatt & Nichol Eng., Long Beach
Hill, Joseph C. - Dept. of San. & Flood Cont., San Diego
Hirsch, Robert - Johns Hopkins U, Baltimore, Maryland
Holland, Mel - State Water Resources Cont. Bd., Sacramento

Inman, Douglas L. - Scripps Institution of Oceanography, La Jolla
Iungerich, Russell - Attorney General's Office, L.A.

Jen, Yuan - Tetra Tech, Pasadena
Jeng, Raymond I. - Cal State Los Angeles
Johnson, Gary - City of Seal Beach

Kalkanis, George - USDA, SCS, Davis
Kelley, Frederic R. - Calif. Div. of Mines & Geol., San Francisco
Kennedy, Michael - Calif. Div. of Mines & Geol., Scripps Institution of Oceanography
Knight, Harold B. - State Dept. of Water Resources, Sacramento
Koh, Robert - Caltech
Koplin, Robert - Corps of Engineers, L.A.
Krieger, Jerold - Dept. of Justice, L.A.

Lee, Jiin-Jen - USC
Lenocker, W. Tracy - Cal State Long Beach
Lewis, Tracy - Caltech
Leyman, Larry - Fullerton College
Light, Simon - Corps of Engineers, L.A.
Lillevang, Omar J. - consulting engineer, 626 Wilshire Blvd., L.A.
Lindgren, Donald R. - L.A. County Flood Control Dist.
List, E. John - Caltech
Longfield, Robert - USGS, Laguna Niguel
Lutz, Stan - Corps of Engineers, L.A.

Magoon, Orville T. - Coastal Eng. Br., U.S. Army Div., San Francisco
Marsh, James A. - U.S. Forest Service, Region 5, San Francisco
McCullough, C. A. - Calif. Dept. of Water Resources, Sacramento
McMurry, Pamela - Caltech
McMurry, Peter - Caltech
Menard, H. William - Scripps Institution of Oceanography, La Jolla
Moore, George T. - Chevron Research, La Habra
Morton, Paul - Calif. Div. of Mines & Geology
Mostafa, M. Gamal - Cal State Long Beach
Muldavin, Clark - Calif. Dept. of Parks and Recreation, Sacramento
Muslin, Dan - Corps of Engineers, L.A.

Nakasone, Herbert - Env. Mgmt. Agency, Santa Ana
Naumann, Jeffrey - L.A. Harbor Dept., San Pedro
Nelson, Carl - Env. Mgmt. Agency, Santa Ana
Nichol, John M. - Moffatt & Nichol Eng., Long Beach
Nordstrom, Charles E. - Scripps Institution of Oceanography, La Jolla
Norouzi, Hadi - L.A. County Flood Control Dist.
Nowak, Gerald - Ventura County Public Works

Ouchi, T. - Corps of Engineers, L.A.

Pawka, Steven - Scripps Institution of Oceanography, La Jolla
Pederson, Gary L. - USGS, Menlo Park
Perrin, Robert E. - L.A. County Flood Control Dist.
Pitzer, Allan - Dept. of Water & Power, L.A.

Raichlen, Fredric - Caltech
Reitmeier, Hal - County of Orange, EMA, Santa Ana
Reynolds, James H. - Whittier College
Robertson, Alexander - Southern Calif. Edison, Rosemead
Robinson, David - CDM, Inc. Environmental Engineers, Pasadena
Robles, Al - Corps of Engineers, L.A.
Rogers, Carlton - Pacific Rock & Gravel, Arcadia
Ross, John Robert - Corps of Engineers, L.A.
Ryono, Takashi - Dept. of Water Resources, L.A.

Salas, Eufronio - Ventura County Public Works
Schlachter, William - Moffatt & Nichol Eng., Long Beach
Schultz, Gail - Comprehensive Planning Organization, San Diego
Scott, Kevin - USGS, Irvine
Scott, Ralph G. - Calif. Dept. of Water Resources, No. Dist., Red Bluff
Serr, Eugene F. - Calif. Dept. of Water Resources, No. Dist., Red Bluff
Seymour, R. J. - Dept. of NOD, La Jolla
Sharp, Robert - Caltech
Sholes, Raymond D. - Southern Calif. Edison, Rosemead
Shreve, Ronald - Geol. & Geophysics, UCLA
Simmons, Mike - USDA, Soil Cons. Svc., Santa Barbara
Sonu, Choule J. - Tetra Tech, Pasadena
Soto, W. J. - Cal State Long Beach
Spencer, Donald G. - Corps of Engineers, L.A.
Steller, David - ESCA-Tech Corp., Long Beach
Stone, Katherine - Dep. of Justice, L.A.
Stratton, David W. - Owl Rock Products Co., Arcadia
Stubchaer, James M. - Santa Barbara Flood Control & Water Cons. Dist.
Sturgess, Bryant - State Lands Comm., Sacramento
Sung, Windsor - Caltech
Sweger, John David - Corps of Engineers, L.A.

Taylor, Brent - EQL, Caltech
Tettmer, John M. - L.A. County Flood Control Dist.
Tennyson, Lynn - Whittier College
Terich, Thomas - West Washington St. College, Bellingham, Washington
Tooby, Paul - Scripps Institution of Oceanography, La Jolla

Ukita, Russell - Corps of Engineers, L.A.
Uzes, Bud - State Lands Div., Sacramento

Vance, Harold A. - L.A. County Flood Control Dist.
Van Ingen, Katherine - Caltech
Vanoni, Vito - Caltech

Wark, John - USGS, Menlo Park
Weis, Niels E. - consulting engineer, Longard Pacific, Newport Beach
Williams, John W. - Calif. Div. of Mines & Geol., San Francisco
Williams, Rhea - USGS, Laguna Niguel
Wilson, Ken - Fugro, Inc., Long Beach
Wisz, John J. - L.A. County Flood Control Dist.
Woolley, C. - USMC, Camp Pendleton

Yang, Richard - Dept. of Justice, L.A.
Young, David - So. Calif. Coastal Wtr. Res. Proj., El Segundo